Sedentism, Territorial Circumscription, and the Increased Use of Plant Domesticates Across Neolithic–Bronze Age Korea

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It is clear that the origins and spread of agriculture from several core regions around the world had a pronounced effect on our planet, and this phenomenon is considered to be one of the most fundamental economic changes in our collective human history. Why this economic transition occurred is still a subject of great debate. Comprehensive edited texts covering this subject and published just in the last decade or so alone include the following: Cowan and Watson 1992; Gebauer and Price 1992; Harris 1996; Price and Gebauer 1995 (see Smith 1998, 2001 for a recent comprehensive review of the subject). Nevertheless, few of these edited volumes include studies from East Asia and more specifically Korea. This essay adds the Korean Holocene record to the discussion that attempts to address the processual "why" plant domesticates spread across Eurasia.[1]

In East Asia, ample archaeological evidence exists that suggests that the origins of millet and rice agriculture occurred in two separate locations. Evidence of foxtail millet *(Setaria italica)* agriculture first appears in the archaeological record in northern China between 9000 and 8000 years B.P. at Cishan and Cha-hai. Northeast Asia, with a cool and dry climate, was and is much better suited for millet cultivation. Rice *(Oryza sativa)* production appears slightly later in southern-central China at the site of Hemudu near Lake Taiku in the Lower Yangzi Valley between 7000 and 5900 years B.P. Southeast and South Asia, with its hot and humid climate, was and is an ideal region for rice to grow. In fact, wild rice *(O. rufipogon)* has been known to grow in monsoon Asia from the Himalayas to the Malay Peninsula and even as far north as the Yangzi River (S. M. An 1991, 2004; K. C. Chang 1986; T. T. Chang 1976, 1983; Crawford 1992; Crawford and Chen 1998; Glover and Higham 1996; Heu 1991; Higham 1995; Higham and Lu 1998; Ho 1977; Smith 1998; Zhao 1998).

It is currently accepted that Korea was a secondary region for agricultural origins. That is, rice and millet domestication originated in China and later spread across the Korean Peninsula (S. M. An 2004; Choe 1982; Crawford and Lee

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TABLE I. GENERAL CHARACTERISTICS OF THE KOREAN NEOLITHIC AND BRONZE AGE

CULTURAL SUBPERIOD	SETTLEMENT PATTERNS	SUBSISTENCE STRATEGIES	TOOL AND STORAGE TECHNOLOGY	OTHER DISTINGUISHING CHARACTERISTICS	REPRESENTATIVE SITES	PRIMARY REFERENCES
Neolithic—Incipient (c. 10,000–8,000 B.P.)	Semisedentary settlement with semisubterranean pithouses along the coast.	Hunting of terrestrial animals and gathering of plants and nuts. If Osanni, Sopohang, and Donggwanjin correctly date to this cultural subperiod, then evidence of utilization of resources from the sea begins to appear.	Fluted projectile points; scrapers; microblades. Early evidence of pottery.	S. M. An (2004) notes that there are as many as 30 sites that fall into this cultural subperiod, though many of them are poorly published or lack solid chronometric dates.	Kosanni, Donggwanjin,[1] Sopohang,[1] Osanni[2]	S. M. An 2004; Choe and Bale 2002; CNUM 1998; Im 2000; Kim and Seo 1972; Kim et al. 1975
Neolithic—Early (c. 8,000–5,500 B.P.)	Sedentary villages comprised of semisubterranean pithouses along major river basins and shell midden sites along the coast that were occupied by semisedentary hunter-gatherers. In some cases, these shell midden sites were probably occupied year-round.	Similar to the Incipient in that there is a continuation of hunting terrestrial game and the collection of plants and nuts. More prevalent in the eastern and southern regions than the west coast of the peninsula is evidence for deep-sea fishing and hunting.	Storage pits appear in pithouses. Pottery widespread. Chipped and ground stone tools predominate, though composite bone tools (e.g., fishhooks, harpoons, needles) appear.	Avian and shellfish remains begin to appear regularly in archaeological sites.	Amsadong, Misari, Osanni, Sangnodaedo, Tongsamdong, Yondaedo, Mokdori	D. G. An 1994; S. M. An 2004; Choe and Bale 2002; Im and Lee 1988; J. J. Lee 2001a; NMK 1994, 1999; Sample 1974; Sohn 1982

Neolithic—Middle (c. 5,500–4,200 B.P.)	Sedentary villages comprised of semisubterranean pithouses along major river basins and shell midden sites along the coast that were probably still occupied by semisedentary hunter-gatherers. Movement inland begins to appear in the archaeological record.	Broad spectrum diet continued in terms of hunting terrestrial and avian game, collection of plants, nuts, and shellfish.	Storage pits appear in pithouses. Pottery widespread. Chipped and ground stone tools predominate. Tools normally associated with plant cultivation begin to appear (e.g., sickles, hoes, querns, digging sticks).	Early evidence for cultivated wild cereals.	Jitamni, Masanni, Sangchonni, Tongsamdong, Songjukni, Daechonni	D. G. An 1994; S. M. An 2004; Choe and Bale 2002; Crawford and Lee 2003; J. J. Lee 2001a; Sample 1974
Neolithic—Late (ca. 4,200–3,500 B.P.)	Sedentary villages comprised of semisubterranean pithouses along major river basins and shell midden sites along the coast that were probably still occupied by semisedentary hunter-gatherers. Inland villages become more common in the archaeological record.	Diet continues to be broad spectrum, but we begin to see an increase in cultivated millet and rice (both domesticated and wild).	Storage pits appear in pithouses. Pottery widespread. Chipped and ground stone tools predominate. Tools normally associated with plant cultivation begin to appear (e.g., sickles, hoes, querns, digging sticks).	Semilunar stone knives begin to appear sporadically. These knives are normally associated with agriculture. Jade ornaments begin to appear in the archaeological record.	Konamri, Sangchonni, Bonggyeri	S. M. An 2004; Choe 1982; Choe and Bale 2002; Crawford and Lee 2003; J .S. Kim 2002; D. J. Lee 2000; J. J. Lee 2001; Norton 2000a; Norton et al. 1999; Rhee and Choi 1992

(Continued)

TABLE I *(Continued)*

CULTURAL SUBPERIOD	SETTLEMENT PATTERNS	SUBSISTENCE STRATEGIES	TOOL AND STORAGE TECHNOLOGY	OTHER DISTINGUISHING CHARACTERISTICS	REPRESENTATIVE SITES	PRIMARY REFERENCES
Bronze Age (3,500–2,300 B.P.)	Inland sedentary villages comprised of semisubterranean pithouses. These villages are larger than the previous Late Neolithic villages. Coastal occupation, particularly shell midden sites, becomes rare.	Cultivated millet and rice become the food staples. Shellfish and utilization of other food resources from the coast decrease significantly.	Storage pits continue to appear in pithouses. Mumun (plainware) pottery widespread. Tools normally associated with plant cultivation predominate (e.g., semilunar knives, sickles, hoes, querns, digging sticks).	Jade ornaments become more common in the archaeological record.	Songgukni, Hunamni, Maejonni, Konamri	S. M. An 2004; J. S. Kim 2002; J. J. Lee 2001a; Norton 2000a; Rhee and Choi 1992; Shin 2001

Notes: 1. No ^{14}C dates for site. 2. One ^{14}C date for Osanni is 12,000 B.P. May be erroneous as the other ^{14}C dates from site range between 7120 B.P. and 5690 B.P. Accordingly, Osanni should more likely be considered an Early Neolithic site.

2003; W. Y. Kim 1986). In this essay, it will be proposed that a number of underlying influences were present during the Holocene in Korea that prompted the transition from a diet that relied primarily on hunting and gathering during the Neolithic to one where full-scale agriculture became the norm during the Bronze Age. Before I explore the possible reasons for the spread of plant domesticates and the factors related to this dietary transition, the general characteristics of the Korean Neolithic and Bronze Age need to be briefly reviewed in order to better understand how or why the process of plant domestication took hold in Korea.

BRIEF OVERVIEW OF THE KOREAN NEOLITHIC AND BRONZE AGE

The Korean Neolithic is from c. 10,000 to c. 3,500 B.P. and the Bronze Age is between c. 3,500 and c. 2,300 B.P. The terms "Neolithic" and "Bronze Age" in Korean archaeology are synonymous with pottery types. The Neolithic is represented by incised pottery. This cultural period is also referred to as "Chulmun" and sometimes "Bissalmuneui." The Bronze Age in Korea begins with the introduction of "Mumun" or plainware and actually predates the establishment of bronze on the peninsula by at least several hundred years. It is sometimes referred to as the Mumun period. Very few traces of complex society currently exist in the Korean Neolithic record, though a plethora of evidence is available to suggest that society during the Korean Bronze Age was stratified (S. M. An 2004; Choe and Bale 2002; J. S. Kim 2002; W. Y. Kim 1986; J. J. Lee 2001a; Norton 2000a; Rhee and Choi 1992). In order to be consistent with other papers I have written on this subject (e.g., Norton 2000a; Norton et al. 1999), I will continue to use the terms "Neolithic" to refer to the time period between c. 10,000 and 3500 B.P. and "Bronze Age" to refer to the time period between 3500 and 2300 B.P.

The Neolithic can be broken down into four cultural stages: Incipient, Early, Middle, and Late (Table 1). The Korean Incipient Neolithic is from c. 10,000 to c. 8,000 B.P. and can be defined by the presence of microblades and pottery in the same context. Evidence for sedentary settlements is often considered to be representative of the Korean Neolithic. During the Incipient Neolithic, however, hunter-gatherers are thought to still have been at least semimobile. Even though as many as 30 sites have been associated with this substage (S. M. An 2004), the most representative site from this cultural subperiod is Kosanni from Chejudo, the southernmost island off the Korean Peninsula (CNUM 1998). Kosanni is an open-air site with ^{14}C dates of 10,400–10,200 B.P. In addition to a diverse stone tool assemblage (700 projectile points, 470 microblades, scrapers, bifaces, and burins), over 1900 Chulmun pottery sherds were discovered during excavations (Choe and Bale 2002; CNUM 1998). This attests not only to the hunting of indigenous deer and wild boar but to the probable storage of prepared foodstuffs (e.g., dried meat, plants, and nuts) to facilitate survival during the lean winter months. For the most part, the other sites that are proposed to date to the Incipient Neolithic either lack ^{14}C dates (e.g., Sopohang, Dongkwanjin, Imbulli) or the associated ^{14}C dates are questionable (e.g., Osanni has one ^{14}C date of 12,000 B.P.).

The advent of the Early Neolithic substage (c. 8,000–5,500 B.P.) in Korea is marked by the introduction of sedentary villages comprised of semisubterranean pithouses along the coast and major inland river basins (see Table 1). Excellent examples of these villages are Amsadong and Misari, which are located right outside of Seoul. In addition, shell midden sites begin to appear along the southern coast of the peninsula (e.g., Sangnodaedo). At some Neolithic shell midden sites, evidence of dwellings has been unearthed (e.g., Tongsamdong). Burials have also been found in these shell midden localities. For instance, 17 burials were found in the Yondaedo site. Burial goods include pottery, beads, and fishing tools (S. M. An 2004; Choe and Bale 2002; J. J. Lee 2001a; Norton 2000a; Rhee and Choi 1992).

Chulmun pottery continues to be present, in addition to evidence for storage pits within many of the pithouses during the Early Neolithic. Chipped and ground stone tools were the primary technology, but composite bone fishhooks and harpoons begin to appear as well. In addition to the first evidence of shellfish utilization in Korea, the presence of bird, fish, and deep-sea mammal remains in some shell midden deposits, along with the composite bone tool technology, attests to the advent of wide-scale utilization of resources from the sea and air. As discussed below, Osanni may present evidence for plant cultivation during the Early Neolithic (S. M. An 2004; Choe and Bale 2002; J. J. Lee 2001a; Norton 2000a; Rhee and Choi 1992).

For the most part, the Middle Neolithic (c. 5,500–4,200 B.P.) is similar to the Early Neolithic (see Table 1). The primary difference is that we begin to see clear evidence of the cultivation of wild cultigens (foxtail millet, barnyard millet) and stone tools normally associated with such activities (e.g., querns, digging sticks). However, hunter-gatherer subsistence continued to rely on hunting of terrestrial game and birds, deep-sea fishing and hunting, and the collection and processing of local plants, nuts, and shellfish. Sites continue to be occupied along the coast (e.g., Tongsamdong), but we begin to see sedentary villages farther inland (e.g., Sangchonni). Middle Neolithic hunter-gatherers continued to utilize Chulmun pottery with regional variation present (west coast: conical pots with pointed bottoms; east and south: flat bases on the vessels) (S. M. An 2004; Choe and Bale 2002; J. J. Lee 2001a; Norton 2000a; Rhee and Choi 1992).

The Late Neolithic (c. 4,200–3,500 B.P.) is when changes in settlement patterns and diet become more evident (see Table 1). Many shell midden sites become less utilized (e.g., Sangnodaedo, Tongsamdong) and an increase in inland occupations occurs. Variation in deep-sea hunting and fishing, along with changes in shellfish collecting patterns, become clear. The shell midden sites that are still occupied during this subperiod (e.g., Konamri) show support for an intensification of the subsistence base. Evidence for the cultivation of wild cereals increases, while palpable proof of other plant domesticates (e.g., rice) begin to appear in the archaeological record. Semilunar knives, which are normally associated with millet and rice agriculture, begin to become visible in Neolithic sites. In addition, jade (early traces of complex society?) is present in some archaeological contexts (S. M. An 2004; Choe and Bale 2002; J. J. Lee 2001a; Norton 2000a; Norton et al. 1999; Rhee and Choi 1992).

The introduction of Mumun pottery ("plainware") signals the beginning of the Bronze Age in Korea (c. 3,500 B.P.) (see Table 1). Many significant changes occur with the transition from the Late Neolithic to the Bronze Age. Even though some of these transformations actually begin during the Middle–Late Neolithic, the changes become more pronounced once millet and rice agriculture became the subsistence base of Korean peoples during the Bronze Age. For instance, just about all of the shell midden sites occupied during the Neolithic are abandoned (exception: Konamri, as discussed below). Coastal occupation is rare as many of the villages moved inland. Mumun pottery is almost always found associated with farming tools (e.g., semilunar knives, stone sickles, hoes, querns, and digging sticks). Jade becomes more common in the archaeological record. Probably one of the most significant changes that occurs with the transition from the Late Neolithic to the Bronze Age is the appearance of dolmen burials. In addition to the marked increase in rice and millet production, all of these factors point to a higher level of sociopolitical complexity than evident during the Neolithic (S. M. An 2004; J. S. Kim 2002; J. J. Lee 2001a; Norton 2000a; Rhee and Choi 1992).

SPREAD OF MILLET AND RICE DOMESTICATES ACROSS NEOLITHIC–BRONZE AGE KOREA

As there is currently an absence of evidence for early Holocene plant domestication in Korea, archaeologists believe that the process of cultivating millet and then later rice diffused from China to the north and east on to the Korean Peninsula and the Japanese archipelago, probably accompanying human population movement and trade (Fig. 1). This is not only due to the absence of plant remains at any of the Incipient Neolithic sites in Korea but to the dearth of tools recov-

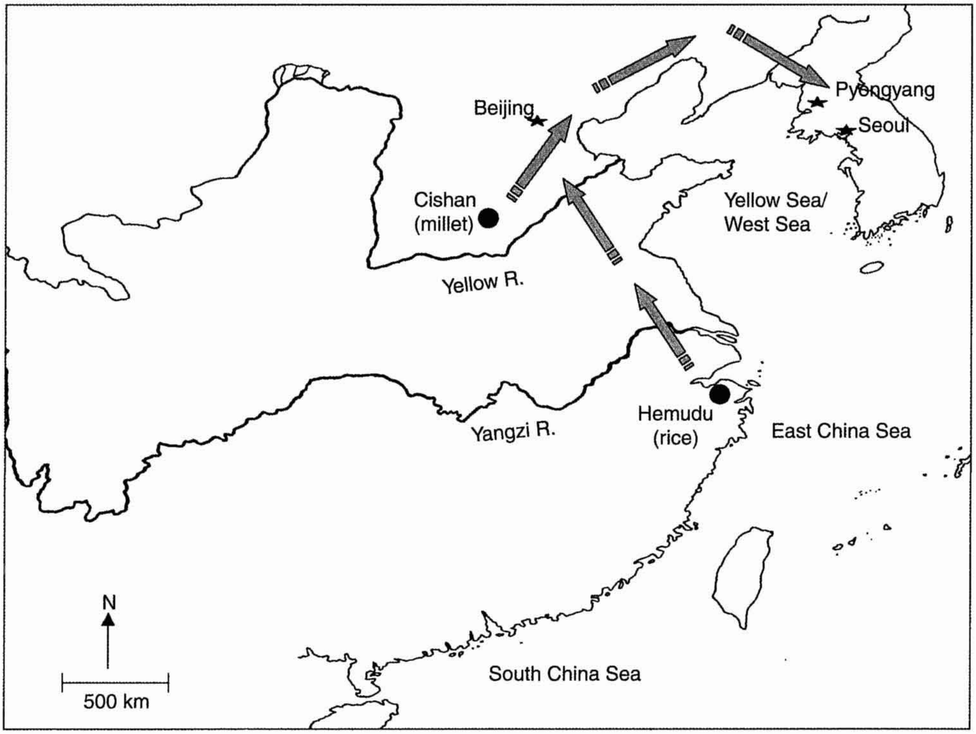

Fig. 1. Probable migration routes of millet *(Setaria italica)* and rice *(Oryza sativa indica)* domesticates from China to the Korean Peninsula by 5500 B.P.

ered that are often associated with the harvesting and processing of plant domesticates (e.g., hoes, querns, sickles). However, it has been proposed that the eastern coastal site of Osanni may date to the Incipient Neolithic or even the Late Palaeolithic. Osanni has a singular ^{14}C date (12,000 ± 50 B.P.), placing it in the Terminal Pleistocene, and excavations at Osanni revealed stone hoes, sickles, and pottery remains, which likely would have been used to process and store cultivated plants. However, the one ^{14}C date appears to be an outlier, as the other seven published ^{14}C dates range between 7120 and 5690 B.P., placing Osanni firmly in the Early Neolithic, which would still be considered early evidence for plant domestication in Korea (S. M. An 1999, 2004; Choe 1982; Choe and Bale 2002; Crawford 1992; Crawford and Chen 1998; Shim 1991).

Foxtail millet *(Setaria italica)* and broomcorn millet *(Panicum milaceum)* appear for the first time in Middle Neolithic deposits at Jitamni and Namgyungni in present-day North Korea and in the Middle Neolithic deposits of Tongsamdong (3640–2940 cal. B.C.), a site located along the southern coast of the peninsula (Table 2). Before a major dam construction project was begun on the Nam River

TABLE 2. CULTIVATED PLANTS RECOVERED FROM KOREAN SITES

SITE	CULTIVATED PLANT	^{14}C	CALIBRATED ^{14}C
House 2, Jitamni, Hwanghaedo	Foxtail millet or barnyard grass	early 4th millenium B.C.	
House 7, Masanni, Hwanghae-do	Foxtail millet	early 4th millenium B.C.	
House 4, Sojeongni, Hwanghae-do	Foxtail millet	Late Chulmun	
House 31, Namgyungni, Pyongyang	Foxtail millet	Late Chulmun	
House 1, Tongsamdong, Pusan	Foxtail and broomcorn millet	4590 ± 100 B.P.[1]	3640–2940 B.C.
House, Sangchon B, Jinju	Foxtail and broomcorn millet	4060 ± 140 B.P.[1]	2920–2200 B.C.
Hearth, Oun 1, Jinju	Foxtail and broomcorn millet	4030 ± 100 B.P.[1]	2880–2240 B.C.
House 1, Daechonni, Okchon	Rice, wheat, barley, Italian millet	4590–4240 B.P.	3520–2550 B.C.
Peat, Seongjeori, Goyang	Rice husks	4070 ± 80 B.P.	2880–2450 B.C.
Peat, Daehwari, Goyang	Rice husks	4330 ± 80 B.P.	3310–2660 B.C.
Peat, Juyeopri, Goyang (pottery)	Rice phytolith	4070–4410 B.P.	3330–2450 B.C.
Peat, Gahyeonni, Kimpo	Rice husks and Italian millet	3890 ± 30 B.P.	2460–2280 B.C.
Chodogni, Chungju (pottery)	Rice phytolith	Late Chulmun	
Suyanggae, Tanyang (pottery)	Rice phytolith	Late Chulmun	
Nongsori, Kimhae (pottery)	Rice phytolith	Late Chulmun	
Oun 1, Jinju	Rice grain	3610 ± 280 B.P.[1]	2860–1320 B.C.

Notes: 1. AMS dating on grain.
Uncalibrated and calibrated ^{14}C dates are listed when dates are considered reliable (after S. M. An 2004; Crawford and Lee 2003).

in the southern part of the Korean Peninsula in 1995, a number of highly intensive salvage archaeological projects were undertaken in the area with sites from all major cultural periods present. During those excavations, flotation for cultigen remains became more common in Korean archaeological excavations, and as a result a large diversity of cultivated plant remains were recovered from a number of Middle Neolithic sites (e.g., Oun, Sangchonni). For instance, carbonized barnyard millet *(Echinochloa frumentaecea)*, barley *(Hordeum satvium)*, beans, acorns, and walnuts were found along with foxtail millet at Sangchonni. Barley, wheat, rice, and millet were recovered from storage pits in houses from the Daechonni, Okchon site. The time range suggests occupation occurred during the Middle–Late Neolithic transition (3520–2550 cal. B.C.). However, the ^{14}C dates from Daechonni were obtained from carbonized materials from the dwellings and not the grains themselves (S. M. An 1998, 1999, 2004; Crawford and Lee 2003; Kwak 2001; Lee and Lee 1998; Rhee and Choi 1992).

Currently, the earliest accepted evidence for the presence of domesticated rice in Korea is the findings from the open-air site of Oun along the Nam River near Jinju, with an AMS date range between 2860 and 1320 cal. B.C. (S. M. An 2004; Crawford and Lee 2003 use 1950 and 1000 cal. B.C. for the same samples). Accordingly, we begin to discern evidence for rice cultivation in the archaeological record dating to the Late Neolithic in Korea. Rice becomes more common in Bronze Age deposits. For instance, clear evidence for rice domestication is from the open-air Bronze Age sites of Chodogni, where charred rice *(Oryza sativa)*, millets *(Setaria italica)*, barley *(Hordeum vulgare)*, and wheat *(Triticum aestivum)* grains were discovered in direct association with Mumun pottery; and Songgukni, where large amounts of rice grains were recovered (S. M. An 1999, 2004; Crawford and Lee 2003; Kwak 2001; G. A. Lee 2000, 2001; Lee and Lee 1998).

It is fairly well accepted that cultivated plants and agricultural techniques were present in sites on the Korean Peninsula by the advent of the Middle Neolithic (c. 5500–4200 B.P.) and possibly by the Early Neolithic (if substantiated by the findings from Osanni). It is also clear that this evidence appears only sporadically in Middle Neolithic deposits and becomes more common in Late Neolithic stratigraphic levels. However, it is not until the advent of the Bronze Age that cultivated cereals become the primary food staple of Korean peoples. The main research question here is: For what reason or reasons did the Korean complex hunter-gatherers come to rely more heavily on plant domesticates as their staple food by 3500 B.P.? Assuming everything remained the same, why change a successful subsistence pattern that appears to have utilized resources from the land (hunting of deer and wild boar, collecting and processing of local plants and nuts), air (hunting of birds), and sea (collecting shellfish, fishing, and deep-sea hunting) for thousands of years?

In attempts to address the question of agricultural origins on the Korean Peninsula, many archaeologists have utilized various kinds of evidence, including the presence/absence of agricultural residues (e.g., S. M. An 1998, 1999), the spread of certain types of polished stone tools (e.g., W. Y. Kim 1986), increased socioeconomic complexity (e.g., J. S. Kim 2001, 2002), change in subsistence patterns by examining the faunal remains from related sites (e.g., Norton 2000a; Norton et al. 1999), or some combination of the above processes (e.g., Choi 2001; J. J. Lee 2001a, 2001b, 2002). The intent here is *not* to discount or minimize the increasing social complexity that occurred during the Holocene in prehistoric

Korea and the role that it may have played in the spread of plant domesticates across the peninsula. However, it is argued here that other factors may have played equally important roles in why rice and millet agriculture became the primary food staples among Bronze Age peoples in Korea. This study continues to emphasize the importance of utilizing *zooarchaeological* data in any reconstructions of *prehistoric diet,* in addition to accounting for environmental influences.

Diet Breadth Contingency Model

In addition to the effect of palaeobathymetric variation during the Holocene, the spread of plant domesticates across the Korean Peninsula can be explained at least partly by the diet breadth contingency model (hereafter "DBM") from behavioral ecology. The basic, underlying premise of the DBM is that a forager, whether human or nonhuman, will prefer to procure a set of resources that offers a relatively high rate of return (based on net energy return) over a food package that is more difficult to obtain and/or process. When a foraging band begins to see diminishing foraging efficiency for selective harvesting of higher-ranked resources, the DBM predicts that less profitable—or originally perceived less important—food sources will be added to the group's overall diet in order to lessen the potential fall in foraging efficiency. Accordingly, when the overall diet reaches the threshold point where the higher-ranked set of resources begins to provide insufficient amounts of the daily recommended calories, proteins, carbohydrates, and fats, lower-ranked food packages will be added to the diet to compensate. Overall diet breadth will in turn expand because lower-ranked resources will be added to a subsistence strategy that will continue to include higher-ranked food packages whenever available (Bettinger 1991, 2001; Gremillion 1996, 2002; Hawkes and O'Connell 1992; Layton et al. 1991; MacArthur and Pianka 1966; Stephens and Krebs 1986; Winterhalder and Goland 1993, 1997; Winterhalder and Smith 2000).

The main reason for the expansion in diet is to maintain the average efficiency of the foraging group in face of potential food shortages that occur due to any number of causes. For instance, if population density increases to the point where a strain is placed on the primary food source (i.e., intensification and overexploitation), then this could cause the resource to decrease in availability (e.g., see Colley 1990 for discussion of the effect of overexploitation of fish). As a result of failure to maintain average foraging efficiency or once this threshold point is reached, a number of events could be faced by the foraging group, including lower encounter rates, lower overall foraging efficiency, a greater likelihood of expanding the diet breadth to include lower-ranked resources, emigration, or even extinction. In many of these cases, if the hunter-gatherer band were sedentary and territorially circumscribed, their mobility options would have been limited; emigration would be increasingly more difficult. In this case, the foraging group would be forced to rely more heavily on a lower-ranked set of resources or attempt to develop socioeconomic relations (e.g., trade) with other hunter-gatherer bands that are "better off" than them in order to maintain their average foraging efficiency. Nevertheless, lower-ranked items should always be ignored, whatever their abundance and/or potential yield, if there is a plenitude of higher-ranked food sources. Accordingly, the DBM predicts that foraging groups would

TABLE 3. GENERAL RANKING OF RESOURCES BASED ON NET ENERGY RETURN RATES AND EXAMPLES OF RESOURCES UTILIZED ON THE KOREAN PENINSULA DURING THE HOLOCENE

RANK	FOOD SOURCE (BASED ON NET ENERGY RETURN RATES, CALCULATED BY DETERMINING KCAL/HOUR)	EXAMPLES OF FOOD RESOURCES PROCURED BY HUNTER-GATHERERS ON THE KOREAN PENINSULA DURING THE HOLOCENE
1	Terrestrial and sea mammals, big fish	e.g., deer *(Cervus nippon)*, pig *(Sus scrofa)*, sea lion *(Zallophus californicus)*, bluefin tuna (*Thunnus* sp. ind.)
2	Fish (small)	e.g., sea bream *(Chrysophrys major)*, sea bass *(Lateolabrax japonicus)*
3	Shellfish, birds	e.g., oysters *(Crassostrea gigas)*, crow *(Corvus corone)*
4	Plants	e.g., millet *(Setaria italica)*, rice *(Oryza sativa indica)*

Notes: Based on behavioral ecology theory and optimal foraging models. Ranking after Winterhalder and Goland 1993; resources after D. G. An 1991, 1994; Norton et al. 1999; Sample 1974; Shin 2001; Sohn 1982.

always select higher-ranked resources until the cost of procuring them outweighs the benefits of doing so. When this occurs, harvesting of originally perceived less-profitable food packages would begin (Bettinger 2001; Winterhalder and Goland 1993, 1997).

The typical ranking of food resources derived through ethnographic and experimental research suggests that terrestrial and sea mammals generally offer the highest net energy return rates (based on kilocalories per hour), followed by fish, shellfish, birds, and finally plant and seed products (Gremillion 1996, 2002; Kelly 1995; Winterhalder and Goland 1993; Yesner 1980) (Table 3). A great deal of variation exists between these general rankings, and in some cases this can mean that the net energy return rate ranges can overlap. Nevertheless, at the broader level the terrestrial and sea mammals, fish, shellfish, birds, and plant ranking still appear to hold true. A heavier reliance on a set of lower-ranked food packages should not necessarily be perceived in a negative light. In some cases they may be high yielding. In other words, a resource that is lower ranked but potentially high yielding is one that—even though it may not have originally been the preferred food source of the group—still has the potential to produce a surplus that is comparable if not greater than higher-ranked resources. As Winterhalder and Goland (1993) justifiably note, many lower-ranked resources can still provide enough calories and nutrients to maintain and possibly facilitate population growth.

The Korean Neolithic–Bronze Age Shell Midden Sites

In order to address questions regarding the nature of the dietary transition between the Korean Neolithic and Bronze Age utilizing the DBM approach, I have chosen to examine the most representative faunal assemblages from these cultural periods. Even though there are a number of other well-published Neolithic sites from the Korean Peninsula (e.g., Amsadong, Misari, Osanni), the majority of them are open-air localities. Due to the extremely poor bone preservation in Korea, if one is interested in reconstructing subsistence patterns of prehistoric people from

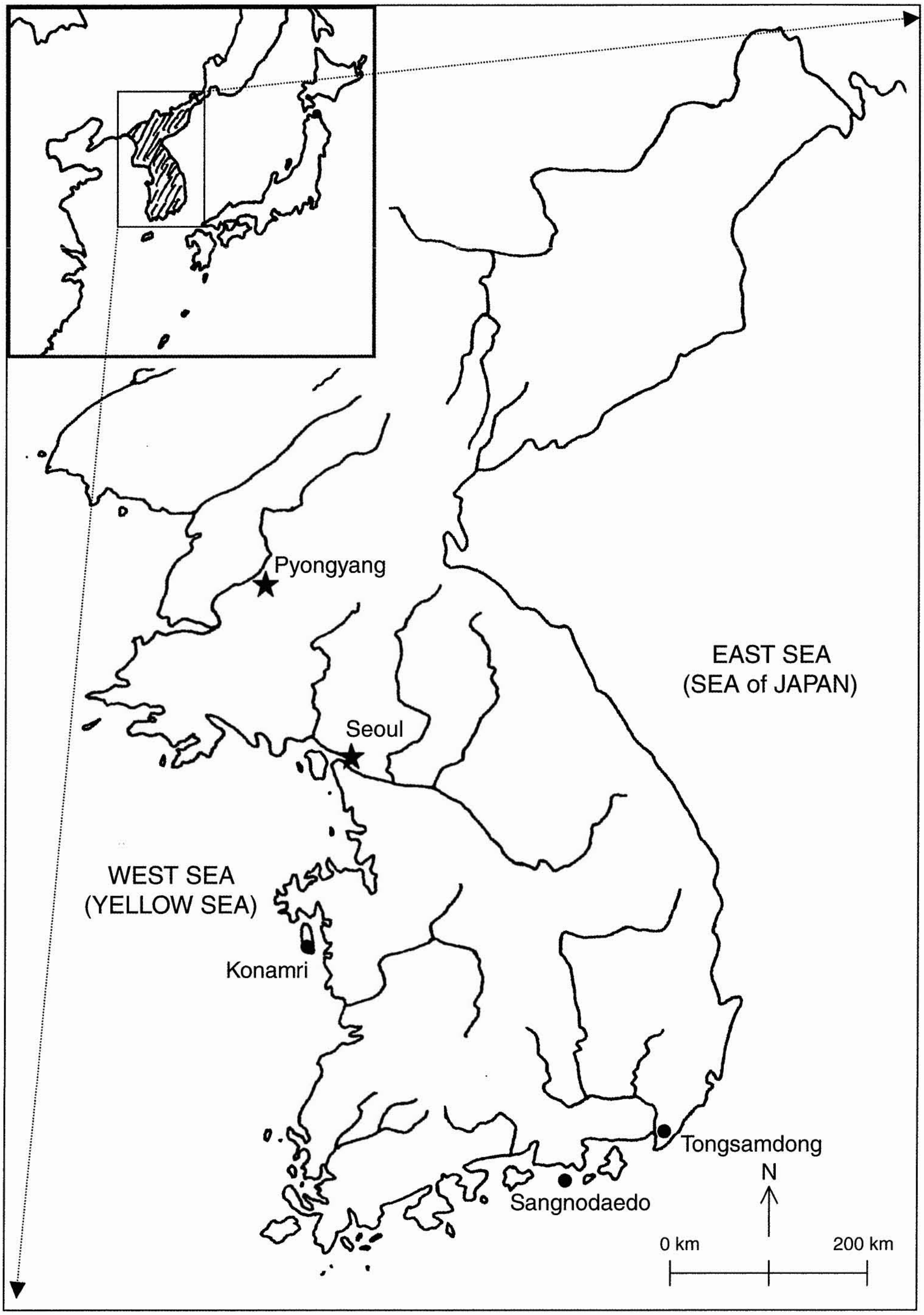

Fig. 2. General map of Korea with the locations of Konamri, Sangnodaedo, and Tongsamdong.

this region one has to examine the faunal remains from either cave sites (in Korea, Late Pleistocene only) or shell middens (in Korea, Holocene only).

Even though a recent review of the Korean Neolithic lists 115 sites as shell middens (J. S. Kim 2002), almost all of these are from small-scale survey investigations and poorly published, and/or any faunal remains recovered from these sites have yet to be studied and/or published. Accordingly, I believe the best faunal accumulations for studying diet change during the Neolithic–Bronze Age transition in Korea are the shell midden sites from Sangnodaedo, Tongsamdong, and Konamri, Anmyundo. These sites are found along the southern and western coasts of the Korean Peninsula, with ^{14}C dates ranging between 6400 and 2400 B.P. (Fig. 2, Tables 4 and 5). Faunal remains from these shell midden sites are ideal for examining variation in Holocene hunter-gatherer diet because their occupation periods correlate well with the Neolithic–Bronze Age transition, in addition to being well published (or directly analyzed by myself in the case of Konamri).

Sangnodaedo was originally discovered in 1978 during an archaeological survey off the southeast coast of the Korean Peninsula by Dong-A University. A joint excavation was later carried out the same year by Dong-A University and Yonsei University. Artifacts discovered included composite bone fishhooks and harpoons, net sinkers, scrapers, and grinding stones, in addition to Chulmun pottery. Faunal remains recovered during excavations indicated that deep-sea hunting took place regularly. Of the 269 identified faunal specimens reported from Sangnodaedo, 45 percent were deep-sea mammals, with the highest NISP count associated with whale (*Cetaceae* sp. ind.). Deer *(Cervus manchuricus, C. nippon)* comprised 40 percent of the faunal assemblage as well, indicating that procurement of large terrestrial game occurred fairly frequently as well. This is in addition to procurement and consumption of fish and shellfish and the likely continued collection and processing of local plants and nuts (Shin 2001; Sohn 1982).

Tongsamdong is located next to the major port city of Pusan in the southeast corner of the Korean Peninsula. It was originally discovered during the Japanese Occupation Period of Korea and excavated by Japanese archaeologists in 1930 and 1932. Korean archaeologists, in collaboration with two American researchers, carried out more detailed excavations during the 1960s. Analysis of the archaeological residues indicated that the Chulmun pottery styles varied through time, suggesting evolution of the indigenous hunter-gatherer groups or different bands occupying the area at discrete points in time. As with Sangnodaedo, composite bone fishhooks and harpoons, net sinkers, scrapers, and grinding stones were discovered at Tongsamdong. Additional fieldwork carried out at the Tongsamdong site by the Municipal Museum of Pusan in 1999 exposed three pithouses, millet remains, stone adzes, and grinding stones from the Middle Neolithic levels. It has been suggested that flotation of residues from the Early Neolithic layers at Tongsamdong may reveal evidence for early plant cultivation in southern Korea (S. M. An 2004; Crawford and Lee 2003). Terrestrial game (deer, wild pig) was found in the same context as fish, bird, and deep-sea mammal remains, attesting to the diversity of the foraging pattern of the residents of Tongsamdong (D. I. An 1994; Oikawa 1933; Sample 1974; Sample and Mohr 1964; Yokoyama 1933). The data utilized in the present study are derived from Sample's publication (1974) of the excavations and analysis of the archaeological data that was carried out in the early 1960s.

TABLE 4. MOST PROMINENT TERRESTRIAL AND SEA MAMMALS, BIRDS, AND FISH GROUPS PRESENT AT SITES IN THIS STUDY

FAMILY	GENUS/SPECIES	COMMON NAME	SANGNO-DAEDO	TONG-SAMDONG	KONAMRI (NEOLITHIC)	KONAMRI (BRONZE AGE)
	Sus scrofa	Wild pig	*	*	*	*
	Hydropetes sp. ind.	Elk	*	*		
	Cervus manchuricus	Manchurian deer	*	*	*	*
	C. nippon horturolum	Japanese deer	*		*	*
	Lutra lutra	Otter	*		*	
	Cetaceae sp. ind.	Whale	*	*		
	Callorhinus ursinus	Fur seal	*			
	Zallophus californicus	Sea lion	*	*		
Delphinidae		Dolphin		*		
Cetorhinidae		Shark		*		
	Muraena pardalis	Dragon eel	*			
	Lateolabrax japonicus	Sea bass	*		*	*
	Chrysophyrys major	Red sea bream	*	*	*	*
	Acanthopagrus sp. ind.	Yellow fin bream	*			*
	Evynnis sp.	Red porgy	*			
Labridae		Ray finned fish	*		*	*
	Sphoeroides sp. ind.	Puffer	*			*
	Thunnus sp. ind.	Bluefin tuna		*		
	Cadus morrha macrocephalus	Cod		*		
	Seriola quinqueradiata	Yellow sea tail (perch)		*	*	*
Rajiformes		Skates, rays			*	*
	Chelonia mydas	Sea turtle	*	*	*	*
	Haliaeetus sp.	Eagle	*	*		
	Corvus corone	Crow	*	*	*	*
	Phalacrocorax sp. ind.	Cormorant	*	*		
	Puffinus leucomelas	Shearwater (seabird)	*	*		

Note: Only species that are represented by an NISP count of 5 are listed here. The two main reasons for this are that a singular occurrence does not necessarily mean that the site's inhabitants were exploiting that particular resource on a regular basis, and misidentifications may have been possible on a small scale (data from D. G. An 1991, 1994; Sample 1974; Sohn 1982).

Konamri is located just off the central west coast of the Korean Peninsula on the southern tip of Anmyundo, the sixth-largest island of Korea. It was originally discovered during an archaeological survey carried out by the Hanyang University Museum research team in 1986. At that time, the remnants of 13 shell midden

TABLE 5. RADIOCARBON DATES FOR KOREAN NEOLITHIC AND BRONZE AGE SITES IN THIS STUDY

SITE	APPROXIMATE OCCUPATION RANGE
Sangnodaedo	6,430 ± 180 B.P.–4,672 ± 190 B.P.
Tongsamdong	6,400 ± 50 B.P.–3,143 ± 135 B.P.
Konamri (Neolithic)	4,150 ± 250 B.P.–3,150 ± 200 B.P.
Konamri (Bronze Age)	2,650 ± 70 B.P.–2,400 ± 100 B.P.

Sources: D. G. An 1991; S. M. An 2004; Choe and Bale 2002; Sample 1974; Sohn 1982.

deposits were exposed; additional sites have since been discovered. Konamri is the only shell midden site found in Korea that is comprised of both Neolithic and Bronze Age deposits, making it possible to do a comparative study of subsistence patterns of people living in this region during the two cultural periods. Mumun pottery was discovered in a midden overlying Neolithic deposits. Also discovered in the Neolithic midden was a diversity of bone tools (composite fishhooks and needles), stone scrapers, and chipped stone tools. Along with the Mumun pottery, stone tools associated with the cultivation of plants (hoes and sickles) were discovered in the Bronze Age midden. Diverse remains of deer, pig, bird, and fish were reported in the middens from both cultural periods. Even though there is a great deal of overlap between these datasets in terms of presence/absence of different species, significant variation does exist (D. I. An 1991; Norton 2000a; Norton et al. 1999).

ENVIRONMENTAL, HUNTER-GATHERER SETTLEMENT, AND DIETARY VARIATION DURING THE KOREAN NEOLITHIC–BRONZE AGE

In this study, I draw on three lines of evidence in order to address questions related to the Korean Neolithic–Bronze Age subsistence transition: (1) resource diversification and intensification of different food resources during the Neolithic; (2) changing sea level/coastline (c. 10,000–4000 B.P.); and (3) shifts in archaeological site locations through time (Late Palaeolithic–Neolithic–Bronze Age).

Resource Diversification and Intensification of Secondary Resources

Very little of the existing evidence currently suggests that what are normally considered lower-ranked resources (e.g., shellfish, birds, turtles) were utilized during the Korean Late Palaeolithic. Even though Late Pleistocene faunal collections are present in Korea, they have either yet to be studied and published or the studies that have been carried out (e.g., Y. J. Lee 1984; Sohn 1980) lack solid theoretical and methodological taphonomic approaches, thus biasing the interpretations (Norton 2000b). In addition, stone and bone implements often associated with the acquisition of shellfish, birds, fish, and deep-sea mammals have yet to be found in Korean Palaeolithic deposits. This contrasts to current research on Late Palaeolithic faunal collections from China and Japan that appear to display evidence for effective hunting and/or the beginning of a diversification of the hunter-gatherer subsistence base (Norton et al. n.d.a; Norton et al. n.d.b).

TABLE 6. COMPARING RATIOS OF NISP/GENERA

SITE	NISP	# OF GENERA	RATIO OF NISP/GENERA
Sangnodaedo	269	16	16.81
Tongsamdong	1,415	11	128.64
Konamri (Neolithic)	7,987	9	887.44
Konamri (Bronze Age)	698	11	63.45

Note: Totals derived from terrestrial macromammals, sea mammals, and fish NISP counts (data from D. G. An 1991; Norton 2000a; Sample 1974; Sohn 1982).

Even during the Incipient Neolithic, if the evidence from Kosanni may be considered representative, it would still appear that hunting of indigenous animals and collecting and processing of local plants and nuts continued to be the primary food acquisition methods. However, by the advent of the Early Neolithic, as evidenced from the shell middens located along the coast of the Korean Peninsula, hunter-gatherer diet breadth expanded (Norton 2000a; Norton et al. 1999).

In examining the diversification and intensification of macromammal remains from the Neolithic and Bronze Age shell midden sites of Sangnodaedo, Tongsamdong, and Konamri, a general pattern appears. When comparing the ratio of number of identifiable specimens (NISP) to the number of genera from each site it appears that the earlier occupied localities exhibit greater diversity (e.g., Sangnodaedo and Tongsamdong) (Table 6).[2] This suggests that subsistence strategies were expanding. By the Late Neolithic, the food acquisition strategy emphasized a narrower range of genera but much more intensively (e.g., Konamri Neolithic midden). Norton and others (1999) were able to show that subsistence intensification at Konamri during the Late Neolithic was heavily focused on the procurement and differential processing of fish, probably for storage and consumption at a later time. Nevertheless, by the advent of the Bronze Age the number of genera once again increases, although the overall NISP count for Konamri decreases significantly from the Neolithic to the Bronze Age. Assuming that the population was stable or increasing and this pattern of intensification and diversification holds true throughout the peninsula, then the Bronze Age Korean peoples must have increasingly been supplementing their main diet with additional food sources that do not appear in the archaeofaunal record.

Shellfish and Birds — Two food sources that appear during the Early Neolithic for the first time in the Korean prehistoric record but that are relatively low on the DBM are shellfish and birds. Shellfish, sessile in nature, are easy to collect. However, they are difficult to process, consume a great deal of time, and do not provide a sufficient daily food supply unless a great many are prepared. Due to the slow maturation rate of shellfish, it is relatively easy to overharvest this resource. Hunting avian prey is difficult, does not necessarily result in captured game at the end of the day, and does not usually result in an adequate food package unless procured in large numbers. Accordingly, in terms of net energy return rate, both prey choices are lower ranked and would normally be ignored if higher-ranked food sources were available (Broughton 1994, 1997, 1999; de Boer 2000; de Boer and Longamane 1996; Kelly 1995; Yesner 1980).

TABLE 7. DESCRIPTIVE DATA OF OYSTERS *(CRASSOSTREA GIGAS)* RECOVERED FROM THE KONAMRI NEOLITHIC AND BRONZE AGE SHELL MIDDENS

	NEOLITHIC	BRONZE AGE
Mean	4.99	6.20
S.D.	0.93	1.44
N	119	161

Notes: Highest counts only. Data from D. G. An 1991.

Both shellfish and birds appear during the Early Neolithic, suggesting that a need arose to begin harvesting these lower-ranked resources by the advent of the Holocene. By the beginning of the Bronze Age, however, these lower-ranked food items appear to be less intensively procured. For instance, two-sample hypothesis testing of oyster *(Crassostrea gigas)* sizes between the Neolithic and Bronze Age remains from Konamri indicates that the size variation observed earlier (Norton 2000a) is marked: $Z = -8.521$, $p < 0.001$ (descriptive data from Table 7). That is, the size of oysters was much smaller during the Neolithic, and this difference is statistically significant. Even though environmental change could be a possible reason for the significant variation in shellfish size in certain regions of the world (e.g., see Spennemann 1987 for his study of Tongan shellfish disparity), the environment did not change significantly around the Konamri occupation site during the Neolithic–Bronze Age transitionary period (c. 3500 B.P.: D. I. An 1991). Accordingly, the variation in average oyster sizes suggests that humans more intensively procured oysters during the Neolithic than during the Bronze Age. Based on presence/absence, avian remains appear early in the Neolithic record and in greater diversity than any time during the Bronze Age (see Table 4). During the Early and Middle Neolithic, as evidenced by Sangnodaedo and Tongsamdong, there is a greater diversity of avian prey procured, but this decreases through time (as data from Konamri suggests). This pattern of decreasing emphasis on hunting birds through the Neolithic and into the early Bronze Age is consistent with the apparent decreasing effort to gather shellfish and procure fish (J. J. Lee 2001a; Norton 2000a; Norton et al. 1999).

Changing Sea Level and Coastline during the Early to Middle Holocene (c. 10,000–4000 B.P.)

Palaeoenvironmental reconstructions of the coastline of Northeast Asia, particularly the region of the present-day West Sea (Yellow Sea), suggest that up until relatively recently much of the area was dry land (Fig. 3). Palaeobathymetric studies of the region indicate that sea level was lowered by up to an estimated 120–140 m in some areas during certain subperiods of the Late Pleistocene (Huang 1984; Kaizuka et al. 1995; Kim et al. 1999; Kwon 1999; Lee and Yoon 1997; Minoura et al. 1997; Norton 2000b; Park 1994, 2001; Qin and Zhao 1994; Sun et al. 2000; Yasuda 1978, 1984; Zheng and Li 2000) (Fig. 4). In fact, in the past it has been proposed that during these periods of extreme climatic change (e.g., the last glacial maximum), the East Sea (Sea of Japan) was a lake with only small tributaries reaching the Pacific Ocean. However, it is currently

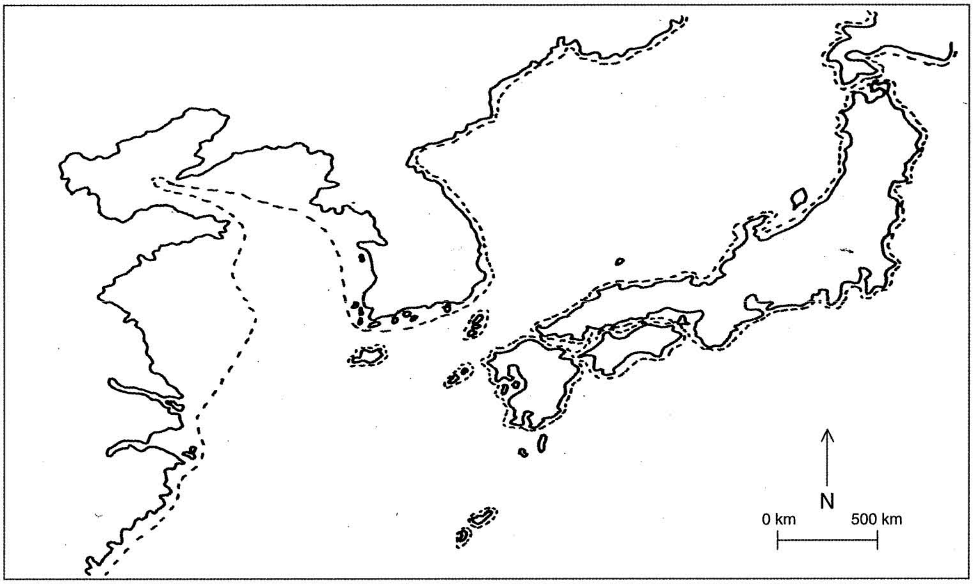

Fig. 3. Outline of the Northeast Asian coastline. The dotted line is a reconstruction of the coastline at 10,000 B.P. and the straight line is the present-day coastline. At 6000 B.P., sea level actually rose above the present-day coastline. Around 4000 B.P., sea level retreated to its present-day position, with only minor fluctuations over the course of the past 4000 years.

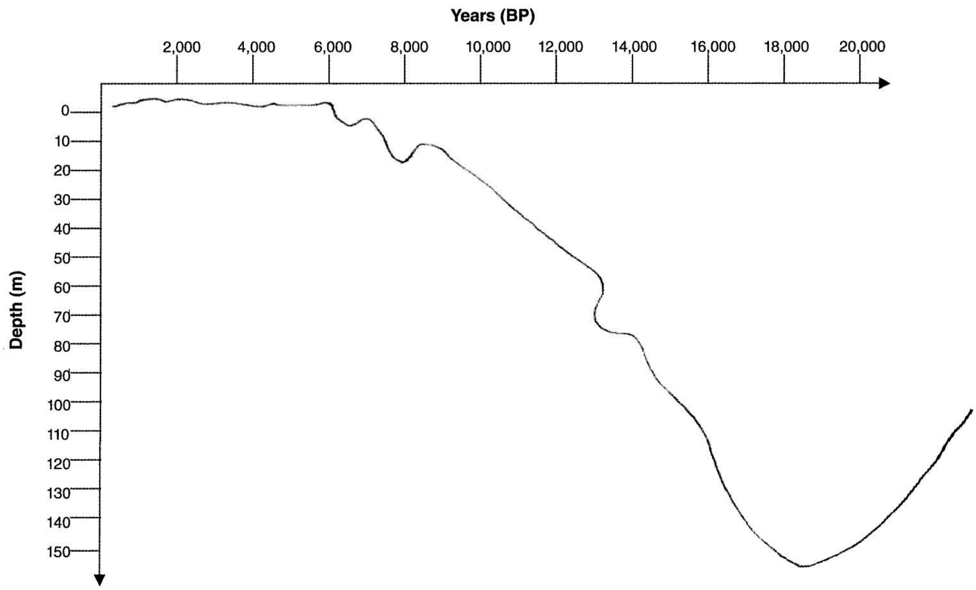

Fig. 4. A reconstruction of bathymetric levels over the course of the past 20,000 years around the Korean Peninsula (redrawn after Park 2001). Not surprisingly, this correlates well with Chinese and Japanese palaeobathymetric reconstructions, though in both of the latter cases the period between 7000 and 5000 B.P. was represented by sea levels higher than the current levels (cf., Kaizuka et al. 1995; Sun et al. 2000; Zheng and Li 2000). Due to the fact that Konamri is roughly 1 km from the current West Sea, I believe that the sea level around the Korean Peninsula between those years would also have been higher than the present day.

believed that the last land bridge connection between the Korean Peninsula and the Japanese archipelago was during the Middle Pleistocene (c. 430,000 B.P.) when Naumann's elephant *(Palaeoloxodon naumanni)* moved into the archipelago (Konishi and Yoshikawa 1999) and likely not during the last glacial maximum (c. 18,000 B.P.) as previously thought.

Nevertheless, it is clear that the peninsula and archipelago shorelines extended closer to each other during the Terminal Pleistocene than at any other time during the Holocene. Analysis of bathymetric reconstructions suggests that sea level around the Korean Peninsula reached its current level by approximately 4000 B.P., although it continued to undergo minor fluctuations—variations that can be measured in meters rather than in tens of meters (Park 2001).

Lowered sea level 10,000 years ago likely would have meant greater group territorial ranges in pursuit of terrestrial mammal resources. In turn, continued procurement of these food packages would suggest that there would have been less of a need to develop complex deep-sea fishing, deep-sea hunting, and/or shellfish collecting technology. In other words, by successfully hunting large game and collecting and processing local plants and nuts, mobile hunter-gatherers would have been able to maintain their average foraging efficiency, and they would not have developed a need to expand their diet breadth at that time. This supposition currently appears to hold true because there is a paucity of archaeological evidence found in Late Palaeolithic deposits (e.g., boats, composite fishhooks and harpoons), suggesting that any use of resources from the sea during the Terminal Upper Pleistocene may have contributed only minimally to the daily protein and carbohydrate intake of hunter-gatherers in this region. Only further research in Korea that addresses Late Palaeolithic hunter-gatherer subsistence strategies will clarify this paradox (Norton et al. in press).

By the middle Holocene (7000–5000 B.P.), the coastal occupation of the shell midden sites of Sangnodaedo, Tongsamdong, and Konamri indicates that the shorelines actually were slightly higher than the present day. For instance, the shell middens from Konamri are currently about 1 km from the West Sea. In addition, data from Chinese and Japanese studies indicate that sea level rose above the current level and then dropped to its current level at this time as well (Kaizuka et al. 1995; Sawai 2001; Sun et al. 2000; Zheng and Li 2000). For example, shell middens have been found in the Tokyo and Osaka regions farther inland from the current coastline. The palaeobathymetric studies from Korea, China, and Japan correlate well with each other, indicating that this was a regional trend.

Shift in Archaeological Site Locations through Cultural Time

Review of the locations of Korean archaeological sites that date to the Late Palaeolithic, Neolithic, and Bronze Age also presents an interesting pattern that is consistent with a shift toward the dominance of agrarian economies (Figs. 5a, 5b, and 5c; Table 8). For instance, most Late Palaeolithic sites are found along major rivers rather than along the present-day coastline of the peninsula. This suggests that the Late Palaeolithic hunter-gatherer groups had a tendency to stay away from large bodies of water (in this case, the West and East Seas). It is actually quite unusual to find a paucity of Palaeolithic sites along the coast of the West Sea because through much of prehistory the region was comprised of dry land

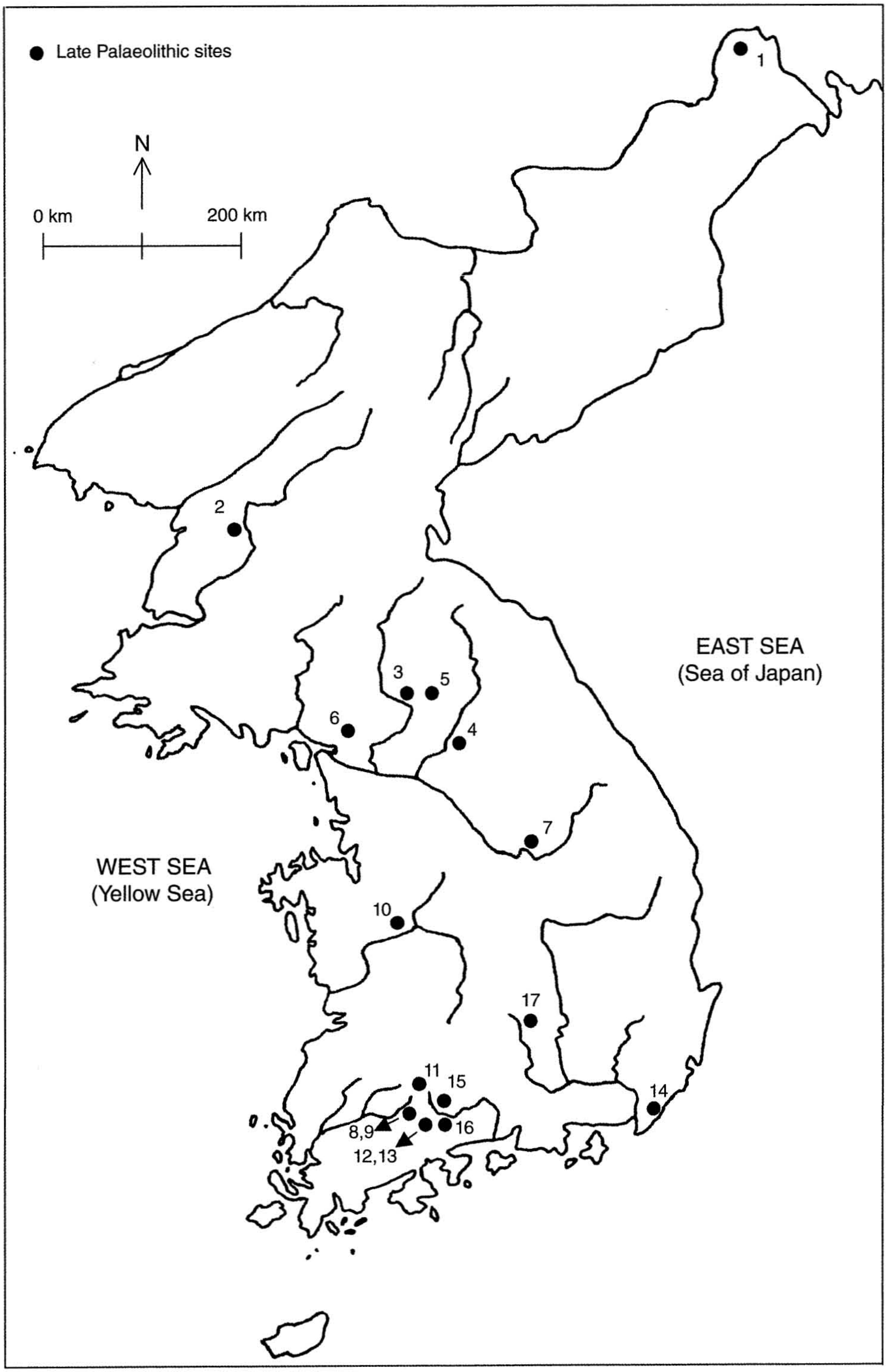

Fig. 5a. Late Palaeolithic sites in Korea (after Norton et al. in press).

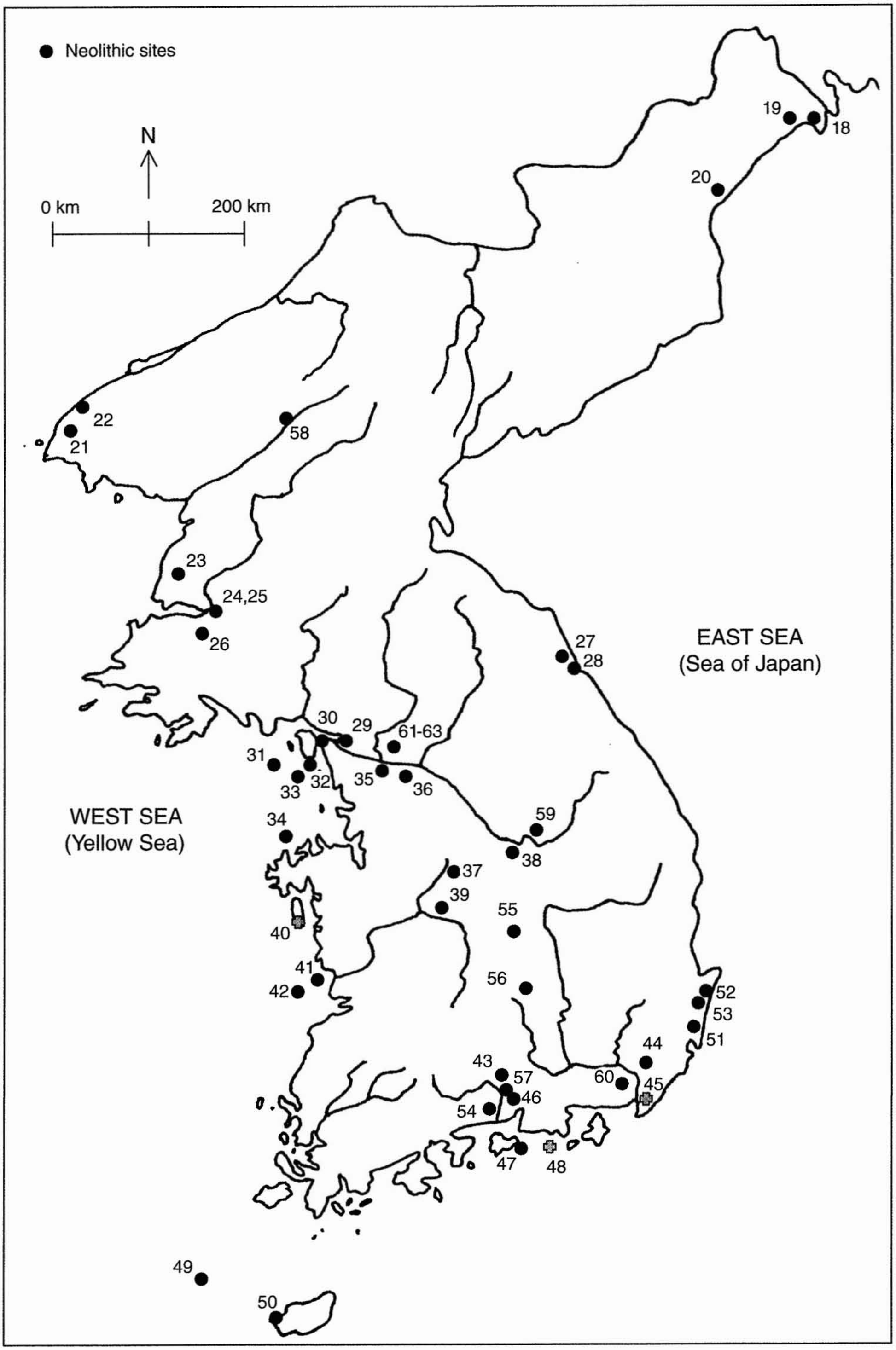

Fig. 5b. Neolithic sites in Korea (modified after Choe and Bale 2002; J. S. Kim 2002; Nelson 1993; Norton 2000a).

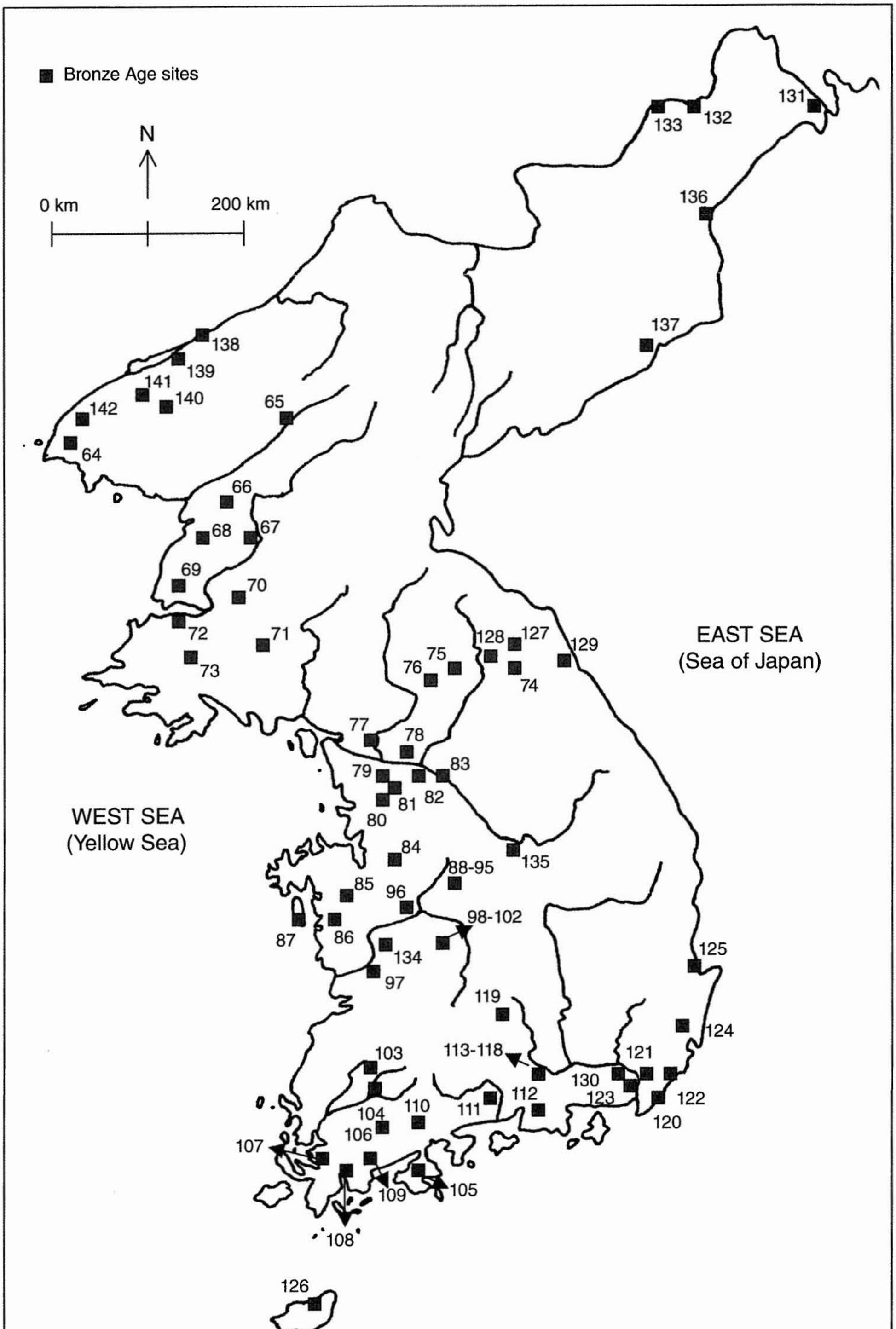

Fig. 5c. Bronze Age sites in Korea (modified after J. S. Kim 2002; Nelson 1993; Norton 2000a).

TABLE 8. PRIMARY LATE PALAEOLITHIC, NEOLITHIC, AND BRONZE AGE SITES FROM THE KOREAN PENINSULA, WITH LOCATIONS PRESENTED ON FIGURES 5A–C

SITE # BY CULTURAL PERIOD	SITE NAME
Late Palaeolithic:	
1	Kulpori
2	Mandalli
3	Sangmuryongni
4	Hahwagyeri
5	Cheolwon, Jangheungni
6	Ouijungbu, Millakdong
7	Suyanggae
8	Taejon, Noeundong
9	Taejon, Hwasun
10	Sokchangni
11	Kokseon, Okkwa
12	Suncheon, Wolpyung
13	Suncheon, Kokcheon
14	Haeundae, Jungdong, and Jwadong
15	Kumpyung
16	Juksan
17	Imbulli
Neolithic:	
18	Sopohang
19	Donggwanjin
20	Nongpodong
21	Shinamni
22	Misongni
23	Gungsanni
24	Namgyungni
25	Masanni
26	Jitamni
27	Osanni
28	Jigyongni
29	Kawaji
30	Gahyeonni
31	Sodo
32	Yongjoongdo
33	Oido
34	Soyado
35	Amsadong
36	Misari
37	Sorori
38	Chodongni
39	Daechonni
40	Konamri, Anmyundo
41	Nogaraeseom
42	Sonyudo
43	Imbulli
44	Sugari
45	Tongsamdong
46	Sangchonni
47	Yondaedo
48	Sangnodaedo
49	Sohuksando
50	Kosanni
51	Sejukni
52	Ubongni
53	Sinamni
54	Mokdori
55	Songjukni
56	Bonggyeri
57	Oun
58	Sojeongni
59	Suyanggae
60	Nongsori
61	Songjori
62	Daehwari
63	Juyopni
Bronze Age:	
64	Sinamni
65	Sojeongni
66	Yonghungni
67	Namgyungni
68	Taesogni
69	Yongdori
70	Simcholli
71	Sinhungdong
72	Soktalli
73	Jitamni
74	Chonjonni
75	Yangsuri
76	Oksongni
77	Yoksamdong
78	Karakdong
79	Susongni
80	Choburi
81	Yanggulli
82	Sangjapori
83	Hunamni
84	Namsongni
85	Naedongni
86	Sangnimni
87	Konamri, Anmyundo
88	Naesuri, Chongwon
89	Oebukdong, Chongju
90	Naesuri, Chongwon
91	Yongam, Chongju
92	Naegokdong, Chongju
93	Ochang, Chongwon
94	Hwangtanri, Chongwon

(Continued)

TABLE 8 (*Continued*)

SITE # BY CULTURAL PERIOD	SITE NAME	SITE # BY CULTURAL PERIOD	SITE NAME
Bronze Age (continued):		118	Sapyongri, Jinyang
95	Songdaeri, Chongwon	119	Chopori
96	Songwonni	120	Tongsamdong
97	Songgunkni	121	Kumgokdong
98	Dunsan, Daejon	122	Tongnae
99	Gungdong, Daejon	123	Nongsori
100	Noeundong, Daejon	124	Songsan
101	Yongsandong, Daejon	125	Innidong
102	Shindaedong, Daejon	126	Pobchonni
103	Songamdong	127	Jungdo
104	Kubongni	128	Sinmaeri
105	Undaeri	129	Kumgangni
106	Usanni	130	Kimhae
107	Changchonni	131	Sopohang
108	Yongam	132	Odong
109	Yanggulli	133	Hogokdong
110	Taegongni	134	Maejonni
111	Sunchon	135	Chodogni
112	Taepyongni	136	Wonsudae
113	Sangchonri, Jinju	137	Tosongni
114	Daepyongni, Jinju	138	Tobongni
115	Okbang, Jinju	139	Tangsan
116	Gwigokdong, Jinju	140	Chonjindong
117	Gwigokdong Daechon, Jinju	141	Kuksongdong
		142	Misongni

Sources: After Choe and Bale 2002; J. S. Kim 2002; Nelson 1993; Norton et al. in press.

with a series of rivers running through it and out to the Pacific Ocean. Thus one might suspect that older Palaeolithic sites would be found closer to the present-day coastline of the West Sea, with younger Palaeolithic sites situated farther inland. Even though this does not appear to be the case, it would be evidence for Palaeolithic hunter-gatherer groups moving farther inland to follow large game resources.

By the advent of the Early Neolithic (c. 8,000 B.P.), site occupations appear not only along major rivers but are positioned along the coast of the peninsula as well. Not only is there a difference in the general locations of Late Palaeolithic and Neolithic sites, but also it is evident that the number of sites increases during the Neolithic (see Figs. 5a and 5b). However, the most distinct difference is between the number and locations of Neolithic and Bronze Age occupations (see Figs. 5b and 5c). Even though the Korean Bronze Age spanned only about 1200 years, it should be evident from reviewing the maps that there is a marked increase in the overall number of sites vis-à-vis the Neolithic record. This suggests an overall increase in population size on the Korean Peninsula at the time. Additional archaeological evidence indicative of an increase in population size is that the size of each individual dwelling and the number of dwellings per settlement increased from the Neolithic to the Bronze Age (S. M. An 2004; J. S. Kim 2002; Rhee and Choi 1992).

Most Bronze Age sites are located away from the coast and farther inland. I argue here and elsewhere (e.g., Norton 2000a) that the primary reason for this was that Bronze Age peoples were motivated to move inland to take advantage of more fertile land to facilitate the transition to a diet that was becoming increasingly dependent on a few high-yield plant domesticates (i.e., millet and rice). This new "farmland" was originally not considered to be the most ideal to carry out a hunting and gathering subsistence strategy and hence was not previously utilized as extensively as the coastal and riverway regions, as evidenced by the paucity of Late Palaeolithic and Neolithic site occupations in these areas. Over 70 percent of the Korean Peninsula is mountainous, with heavily forested regions (Kwon 1999; Norton 2000b), and so it is not ideal for mobile hunter-gatherers to move across the landscape in pursuit of terrestrial game. Accordingly, it probably would have been difficult for Late Pleistocene–Early Holocene hunter-gatherers to successfully penetrate these regions if relying primarily on higher-ranked food resources (e.g., deer, wild boar).

Variation in terms of labor between wet and dry plant agriculture may be related to the move to find better farming land. Dry cultigen agriculture (e.g., millet) does not involve as much labor investment as wet rice agriculture simply because there is not as much upkeep. In the case of dry farming, the households can more or less clear an area, plant the seeds, and then periodically return to make sure the plants are growing properly and that no humans or animals are appropriating the plants as they grow (in particular, scavengers such as birds and rodents have been known to wreak havoc on farmland). Nevertheless, not only do wet rice farmers have to deal with these hazards, they also have to constantly ensure that the irrigation system is working at the optimal level. In addition, because wet rice farmers sometimes try to grow two or even three crops in a year, the soil must be constantly fertilized and replenished, which suggests more irrigation maintenance. Evidence for this appears in the form of irrigation canals and water reservoirs at the Majeonni site. The land along the coast of the Korean Peninsula apparently did not facilitate such a lifestyle and encouraged the newly dependent farmers to move farther inland to find better agricultural land. In relocating, Bronze Age peoples were able to take advantage of higher elevations, where utilizing gravity-fed irrigation systems facilitated the continuous replenishment of the soil and hence the production of a high-yield food package (Crawford and Lee 2003; H. J. Lee 2000).

DISCUSSION AND CONCLUSIONS

The spread of agriculture across the Korean Peninsula and the rise of social complexity are sometimes compared with contemporaneous archaeological evidence from the Japanese archipelago. Even though it may not be the primary reason, I believe one causal factor related to the spread of agriculture and the associated rise in social complexity in Japan is the increased dependence on a seasonal food source: dog salmon *(Oncorynchus keta)* and trout *(O. masou)* (Akazawa 1981, 1986; Imamura 1996; Matsui 1996). However, unlike Japan (and northwestern North America), anadromous fish are not prevalent in Korea. Therefore, developing intensive fish collecting strategies and associated complex social networking similar to the Jomon in Japan or the northwestern American Indians never arose in Korea. The lack of a need to develop the type of social relations and social networks often required to carry out the annual intensive harvesting of anadromous fish (e.g., competition over favorite fishing spots) meant that each Neolithic Korean village was still more or less autonomous. This may be part of the reason why stylistically, Chulmun pottery never developed to the level of sophistication clearly visible in contemporary Jomon ceramic assemblages. Increased competition over limited resources usually leads to any number of changes on the sociopolitical landscape of the region (e.g., Jomon: extremely sophisticated development of their pottery; Kwakiutl: potlatch). Lack of this type of reliable resource during the Korean Neolithic suggests we should investigate other reasons for the significant subsistence transition during the Holocene.

Elsewhere I presented a model for why a nonindigenous food source (cultivation of millet and rice) was accepted by foragers living on the Korean Peninsula during the middle Holocene (Norton 2000a). The basic premise is as follows: By the beginning of the Holocene, Korean hunter-gatherers were living in villages along the coasts and major riverways in what may be deemed an ecotone. In other words, the Korean Neolithic inhabitants had access to a diversity of food packages (see Table 4) that included the procurement of resources from the land, sea, and air. They were able to lead a sedentary or semisedentary lifestyle through expansion of diet breadth and the use of storage (Norton et al. 1999). Due to an increase in human population size resulting from this sedentary life, hunter-gatherers faced territorial circumscription. In turn, Korean peoples found themselves unable to maintain their overall foraging efficiency, which eventually led to the heavier reliance on lower-ranked resources—in some cases intensively and possibly leading to overexploitation. During the initial periods of food intensification, a wider diversity of dietary packages was procured that included cultivated plant products. By the Late Neolithic there is a decrease in utilization of fish, shellfish, and birds that coincides with the apparent increased reliance on plant domesticates (e.g., millet and rice), the latter becoming the main staple of Korean Peninsular peoples by the advent of the Bronze Age 3500 years ago.

From this current review and analysis of the Korean archaeological and palaeoenvironmental records, several points appear to support the model described above as a multicausal explanation for addressing the question of why plant domesticates spread across the Korean Peninsula during the Holocene. Why they may have waited so long to begin utilizing plant domesticates may be explained by what was detailed above and briefly outlined as follows.

Very little archaeological evidence of coastal occupation currently exists that predates 10,000 B.P. The majority of Korean Late Palaeolithic cultural period occupations are either cave or inland riverway sites away from the coast. This correlates well with the current lack of evidence of a Palaeolithic subsistence strategy that included any utilization of food resources from the sea. Even though absence of evidence is not evidence for absence, composite tools (e.g., net sinkers, bone fishhooks, harpoons) normally associated with fishing, shellfish collecting, and large sea-mammal hunting have yet to be found in Palaeolithic deposits in Korea. As scientific research investigating the Korean Palaeolithic continues, this may change, but for now it appears that any utilization of these resources by Palaeolithic hunter-gatherers was probably minimal. Kosanni, the most representative Korean Incipient Neolithic site, provides us with a picture that suggests the hunter-gatherers from this region continued to rely heavily on hunting of terrestrial game and the collecting and processing of local plants and nuts.

Sea levels rose during the Holocene, stabilizing around 4000 B.P., and Neolithic hunter-gatherers went from semisedentary to sedentary living. These two factors resulted in increasing numbers of villages during the Neolithic, which probably led to some degree of territorial circumscription. This simply meant that with increasing population pressure, the Korean Neolithic coastal hunter-gatherers found it more difficult to move up or down the coast in order to continue following a similar subsistence strategy.

As the number of site occupations increased during the Neolithic and mobility options decreased, it would appear that it became increasingly more difficult to continue to rely simply on the procurement of large game resources and the collection and processing of local plants and nuts. This likely prompted Korean Neolithic peoples to expand their diet breadth to include procurement of food resources such as shellfish, fishing, and avian faunae in order to minimize declining foraging efficiency, in some cases extremely intensively (e.g., fish utilization at Konamri). This also included the small-scale cultivation of plants (e.g., millets).

With the ever increasing population on the peninsula, people came to rely more heavily on a potentially high-yield resource (i.e., rice agriculture). Once Korean peoples developed a heavier dependence on plant domesticates, this new primary subsistence strategy drew many households farther inland and away from the coasts in order to utilize more fertile farming land. This is evidenced by the dearth of coastal Bronze Age sites on the Korean Peninsula. In some cases, entire villages may have relocated farther inland, or in other instances only part of the village may have moved. The latter instance may have been the case with the Late Neolithic–Bronze Age coastal shell midden site of Konamri and the nearby fully agricultural Bronze Age inland site of Songgukni, which appear to have had some type of socioeconomic relationship. This dietary transition promoted an even more pronounced increase in human population density, which by the advent of the Bronze Age led to substantial changes to the Korean socioeconomic landscape. Increasing societal demands for labor and trade would only have prompted people to increase their production of millet and rice.

As should be evident from this discussion, people do not normally change a subsistence strategy that worked fine for thousands of years just for the sake of change. There is usually a motivating dynamic involved. In this case, in addition to increasing social complexity, there were likely a number of equally important factors, including rising sea level, long-term effects of sedentism, increasing population pressure, and territorial circumscription that prompted many of these changes.

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NOTES

1. Whenever possible, calibrated ^{14}C dates ("cal. B.C.") are cited here. However, in some cases only uncalibrated ^{14}C were published ("B.P.").
2. NISP counts were employed here rather than MNE (minimum number of elements), MNI (minimum number of individuals), or MAU (minimum animal units) (as defined by Binford 1984; Grayson 1984; Klein and Cruz-Uribe 1984) because the bone collection methods employed by the excavators (Sample 1974) of the Tongsamdong shell midden may be in question. There is a fairly strong possibility that only the most identifiable bone specimens were retained and/or included in the published Tongsamdong excavation report. However, the integrity of the other two faunal assemblages (Konamri and Sangnodaedo) is without this problem because the excavation methods have been well documented elsewhere. At Konamri, 3 mm screens were utilized during the excavations with every piece of archaeofaunal material retained (D. I. An 1991; Norton et al. 1999). The quality of the excavations by Sohn Powkey and Yonsei University Museum at Sangnodaedo and other open-air and cave sites is well known (Norton 2000b; Norton, personal observation 2002; Sohn 1982). Accordingly, because NISP counts face the least amount of problems with rounding error vis-à-vis MNE, MNI, or MAU (Grayson 1984; Zhang and Norton n.d.), the former counting method is utilized for comparative analysis across different faunal assemblages excavated by different archaeologists during different excavation time periods (i.e., the 1960s, 1970s, 1980s, and 1990s).

REFERENCES

AKAZAWA, T.

1981 Maritime adaptation of prehistoric hunter-gatherers and their transition to agriculture in Japan. *Senri Ethnological Studies* 9:213–258.

1986 Hunter-gatherer adaptations and the transition to food production in Japan, in *Hunters in Transition:* 151–166, ed. M. Zvelebil. Cambridge: Cambridge University Press.

AN, D. I.

1991 A Study of the Konam-ri Shell Middens, Korea. Ph.D. diss. University of London.

1994 Tongsam-dong shell midden and animal remains: Focusing on the archaeological data from L. L. Sample's excavation. *Journal of the Korean Archaeological Society* 31:297–340 (in Korean).

AN, S. M.

1991 Early rice cultivation in Southeast Asia. *Journal of the Korean Archaeological Society* 27:96–155 (in Korean).

1998 *East Asia Prehistoric Farming and Occupation.* Seoul: Hakyounmunhwasa Publishers (in Korean).

1999 *Asian Rice Cultivation's Origin and Specialization.* Seoul: Hakyounmunhwasa Publishers (in Korean).

2004 The beginning of agriculture and sedentary life and their relation to social changes in Korea, in *Cultural Diversity and the Archaeology of the 21st Century:* 40–61. Society of Archaeology Studies, Japan.

BETTINGER, R. L.

1991 *Hunter-Gatherers: Archaeological and Evolutionary Theory.* New York: Plenum Press.

2001 Holocene hunter-gatherers, in *Archaeology at the Millennium: A Sourcebook:* 137–195, ed. G. M. Feinman and T. D. Price. New York: Kluwer Academic/Plenum Publishers.

BINFORD, L. R.

1984 *Faunal Remains from Klasies River Mouth.* Orlando: Academic Press.

BROUGHTON, J. M.

1994 Declines in mammalian foraging efficiency during the Late Holocene, San Francisco Bay, California. *Journal of Anthropological Archaeology* 13:371–401.

1997 Widening diet breadth, declining foraging efficiency, and prehistoric harvest pressure: Ichthyofaunal evidence from the Emeryville Shellmound, California. *Antiquity* 71:845–862.

1999 *Resource Depression and Intensification during the Late Holocene, San Francisco Bay.* Berkeley: University of California Press.

CHANG, K. C.

1986 *The Archaeology of Ancient China,* 4th ed. New Haven: Yale University Press.

CHANG, T. T.
1976 The origin, evolution, cultivation, dissemination, and diversification of Asian and African rices. *Euphytica* 25:425–441.
1983 The origins and early cultures of the cereal grains and food legumes, in *The Origins of Chinese Civilization:* 65–94, ed. D. N. Keightley. Berkeley: University of California Press.

CHOE, C.
1982 The diffusion route and chronology of Korean plant domestication. *Journal of Asian Studies* 41:19–29.

CHOE, C., AND M. T. BALE
2002 Current perspectives on settlement, subsistence, and cultivation in prehistoric Korea. *Arctic Anthropology* 39:95–121.

CHOI, K. R.
2001 The beginning of rice farming and the natural environment. Paper presented at the Korean Archaeology Society Conference 25:9–19 (in Korean).

CNUM
1998 *The Cheju Kosan-ri Site.* Cheju City: Cheju National University Museum (in Korean).

COLLEY, S. M.
1990 The analysis and interpretation of archaeological fish remains, in *Advances in Archaeological Method and Theory,* vol. 2:207–253, ed. M. B. Schiffer. Tucson: University of Arizona Press.

COWAN, C. W., AND P. J. WATSON, EDS.
1992 *The Origins of Agriculture: An International Perspective.* Washington, DC: Smithsonian Institution Press.

CRAWFORD, G.
1992 Prehistoric plant domestication in East Asia, in *The Origins of Agriculture: An International Perspective:* 7–38, ed. C. W. Cowan and P. J. Watson. Washington, DC: Smithsonian Institution Press.

CRAWFORD, G. W., AND CHEN SHEN
1998 The origins of rice agriculture: Recent progress in East Asia. *Antiquity* 72:858–866.

CRAWFORD, G. W., AND G. LEE
2003 Agricultural origins in the Korean Peninsula. *Antiquity* 77:87–97.

DE BOER, W. F.
2000 *Between the Tides: The Impact of Human Exploitation on an Intertidal Ecosystem, Mozambique.* Veenendaal, Netherlands: Universal Press.

DE BOER, W. F., AND F. A. LONGAMANE
1996 The exploitation of intertidal food resources in Inhaca Bay, Mozambique, by shorebirds and humans. *Biological Conservation* 78:295–303.

GEBAUER, A. B., AND T. D. PRICE, EDS.
1992 *Transitions to Agriculture in Prehistory.* Madison, WI: Prehistory Press.

GLOVER, I. A., AND C.F.W. HIGHAM
1996 New evidence for early rice cultivation in South, Southeast, and East Asia, in *The Origins and Spread of Agriculture and Pastoralism in Eurasia:* 413–441, ed. D. R. Harris. Washington, DC: Smithsonian Institution Press.

GRAYSON, D. K.
1984 *Quantitative Zooarchaeology.* New York: Academic Press.

GREMILLION, K. J.
1996 Diffusion and adoption of crops in evolutionary perspective. *Journal of Anthropological Archaeology* 15:183–204.
2002 Foraging theory and hypothesis testing in archaeology: An exploration of methodological problems and solutions. *Journal of Anthropological Archaeology* 21:142–164.

HARRIS, D. R., ED.
1996 *The Origins and Spread of Agriculture and Pastoralism in Eurasia.* Washington, DC: Smithsonian Institution Press.

HAWKES, K., AND J. O'CONNELL
1992 On optimal foraging models and subsistence transitions. *Current Anthropology* 33:63–66.

HEU, M. H.
1991 Origin and introduction of domesticated rice in Korea. *Journal of the Korean Archaeological Society* 27:59–95 (in Korean).

HIGHAM, C.F.W.
1995 The transition to rice cultivation in Southeast Asia, in *Last Hunters, First Farmers: New Perspectives on the Prehistoric Transition to Agriculture:* 127–155, ed. T. D. Price and A. B. Gebauer. Sante Fe: School of American Research Press.

HIGHAM, C.F.W., AND T.L.D. LU
1998 The origins and dispersal of rice cultivation. *Antiquity* 72:867–877.

HO, P. T.
1977 The indigenous origins of Chinese agriculture, in *Origins of Agriculture:* 413–484, ed. C. A. Reed. The Hague: Mouton Publishers.

HUANG, J. S.
1984 Changes of sea-level since the Late Pleistocene in China, in *The Evolution of the East Asian Environment:* 309–319, ed. R. O. Whyte. Hong Kong: Centre of Asian Studies, University of Hong Kong.

IM, H. J.
2000 Archaeological research on the Kimpo Peninsula, Kyunggi-do. *Annual Bulletin of Seoul National University Museum* 2:1–22 (in Korean).

IM, H. J., AND J. J. LEE
1988 *Osanni Site III.* Archaeological and Anthropological Papers 13. Seoul: Seoul National University Museum (in Korean).

IMAMURA, K.
1996 *Prehistoric Japan.* Honolulu: University of Hawai'i Press.

KAIZUKA, S., Y. NARUSE, Y. OTA, AND K. KOIKE
1995 *Lowlands and Coasts of Japan,* 2nd ed. Vol. 4 of *Nature in Japan.* Tokyo: Iwanami Shoten (in Japanese).

KELLY, R. L.
1995 *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways.* Washington, DC: Smithsonian Institution Press.

KIM, J. S.
2001 Elite strategies and the spread of technological innovation: The spread of iron in the Bronze Age societies of Denmark and southern Korea. *Journal of Anthropological Archaeology* 20:442–478.
2002 The Late Neolithic–Early Bronze Age Transition and Cessation of Island Exploitation in Central-Western Korea: The Spread of Territoriality into a Mobile Hunter-Gatherer Context. Ph.D. diss. Tempe: Arizona State University.

KIM, W. Y.
1986 *Art and Archaeology of Ancient Korea.* Seoul: Taekwang Publishing.

KIM, Y. G., AND G. T. SEO
1972 Report of the Sopohang prehistoric remains. *A Collection of Ancient Folklore Studies* 4:31–145 (in Korean).

KIM, Y. H., H. J. LEE, S. S. CHUN, S. J. HAN, AND S. K. CHOUGH
1999 Holocene transgressive stratigraphy of a macrotidal flat in the southeastern Yellow Sea: Gomso Bay, Korea. *Journal of Sedimentary Research* 69:328–337.

KLEIN, R. G., AND K. CRUZ-URIBE
1984 *The Analysis of Animal Bones from Archeological Sites.* Chicago: University of Chicago Press.

KONISHI, S., AND S. YOSHIKAWA
1999 Immigration times of the two proboscidean species, *Stegodon orientalis* and *Palaeoloxodon naumanni,* into the Japanese islands and the formation of land bridges. *Earth Science* 53:125–134.

KWAK, J. C.
2001 Korea's prehistory to ancient times agriculture. Paper presented at the Korean Archaeology Society Conference 25:21–73 (in Korean).

KWON, H. J.
1999 *The Geography of Korea,* 2nd ed. Seoul: Bopmunsa (in Korean).

LAYTON, R., R. FOLEY, AND E. WILLIAMS
1991 The transition between hunting and gathering and the specialized husbandry of resources. *Current Anthropology* 32:255–274.

LEE, G. A.
2000 Analysis of the plant remains from the 11th excavation of the Songgukni site, in *Songgukni Excavation Report,* no. 6:143–154. Puyo: Puyo National Museum (in Korean).
2001 Analysis of the plant remains from the Okbang Locality 1 site, in *Excavation Report of Jinju Taepyungni Okbang I Site,* no. 14:254–256. Jinju: Jinju National Museum (in Korean).

LEE, H. J.
2000 Early wet-rice agriculture in Korea. *Korean Journal of Agriculture and Industry* 42:1–13 (in Korean).

LEE, H. J., AND S. H. YOON
1997 Development of stratigraphy and sediment distribution in the northeastern Yellow Sea during Holocene sea-level rise. *Journal of Sedimentary Research* 67:341–349.

LEE, J. J.
2001a *From Shellfish Gathering to Agriculture in Prehistoric Korea: The Chulmun to Mumun Transition.* Ph.D. diss. University of Wisconsin, Madison.
2001b Theoretical approaches to the transition to agriculture in prehistoric Korea. *Youngnam Archaeology* 10:1–33 (in Korean).
2002 Functional variation of shell midden patterns in southern Korea. *Journal of the Korean Archaeological Society* 46:53–80 (in Korean).

LEE, S. G., AND G. A. LEE
1998 The excavation and recovery of plant remains from the Taepyung Oun site. *Youngnam Archaeology* 7:99–110 (in Korean).

LEE, Y. J.
1984 *Early Man in Korea,* vol. 2. Seoul: Tamgu-Dang Publishing (in Korean).

MACARTHUR, R. H., AND E. PIANKA
1966 On optimal use of a patchy environment. *American Naturalist* 100:603–609.

MATSUI, A.
1996 Archaeological investigations of anadromous salmonid fishing in Japan. *World Archaeology* 27:444–460.

MINOURA, K., K. HOSHINO, T. NAKAMURA, AND E. WADA
1997 Late Pleistocene–Holocene paleoproductivity circulation in the Japan Sea: Sea-level control on $\delta^{13}C$ and $\delta^{15}N$ records of sediment organic material. *Palaeogeography, Palaeoclimatology, Palaeoecology* 135:41–50.

NELSON, S. M.
1993 *The Archaeology of Korea.* Cambridge: Cambridge University Press.

NMK
1994 *Amsadong Site.* Report of the Research of Antiquities 26. Seoul: National Museum of Korea (in Korean).
1999 *Amsadong Site II.* Report of the Research of Antiquities 30. Seoul: National Museum of Korea (in Korean).

NORTON, C. J.
2000a Subsistence change at Konam-ri: Implications for the advent of rice agriculture in Korea. *Journal of Anthropological Research* 56:325–348.
2000b The current state of Korean paleoanthropology. *Journal of Human Evolution* 38:803–825.

NORTON, C. J., K. BAE, AND J. W. K. HARRIS
In Press A review of Korean microlithic industries, in *Origin and Spread of Microblade Technology in Northern Asia and North America,* ed. S. Keates, S. Kuzmin, and S. Chen.

NORTON, C. J., X. GAO, AND S. Q. ZHUANG
n.d.a Zhoukoudian Upper Cave revisited: A taphonomic perspective. Unpublished manuscript.

NORTON, C. J., B. KIM, AND K. BAE
1999 Differential processing of fish during the Korean Neolithic: Konam-ri. *Arctic Anthropology* 36:151–165.

Norton, C. J., Y. Hasegawa, N. Kohno, and Y. Tomida
n.d.b Distinguishing archaeological and paleontological faunal collections from Pleistocene Japan: Taphonomic perspectives from Hanaizumi. Unpublished manuscript.

Oikawa, T.
1933 The Tongsamdong shellmound on Yongdo in South Korea. *Kokogaku* 4:139–148 (in Japanese).

Park, Y. A.
1994 The sea level and coastal shoreline of the early and middle Holocene in the Yellow Sea, in *Environment and Culture in the Yellow Sea Region:* 7–13, ed. B. M. Kim and K. D. Bae. Seoul: Hakyounmunhwasa Publishing (in Korean).
2001 *Korean Quaternary Environment.* Seoul: Seoul National University Press (in Korean).

Price, T. D., and A. B. Gebauer, eds.
1995 *Last Hunters, First Farmers: New Perspectives on the Prehistoric Transition to Agriculture.* Santa Fe: School of American Research Press.

Qin, Y. S., and S. L. Zhao
1994 The natural features of the continental shelf of the East China Sea in the Late Pleistocene, in *Environment and Culture in the Yellow Sea Region:* 15–16, ed. B. M. Kim and K. D. Bae. Seoul: Hakyounmunhwasa Publishing (in Korean).

Rhee, S. N., and M. L. Choi
1992 Emergence of complex society in prehistoric Korea. *Journal of World Prehistory* 6:51–95.

Sample, L. L.
1974 A contribution to Korean Neolithic culture history. *Arctic Anthropology* 11:1–125.

Sample, L. L., and A. Mohr
1964 Progress report on archaeological research in the Republic of Korea. *Artic Anthropology* 2:99–104.

Sawai, Y.
2001 Episodic emergence in the past 3000 years at the Akkeshi Estuary, Hokkaido, Northern Japan. *Quaternary Research* 56:231–241.

Shim, B. K.
1991 Prehistoric rice cultivation in Korea. *Journal of the Korean Archaeological Society* 27:5–58 (in Korean).

Shin, S. J.
2001 The Korean Bronze Age subsistence economy. *Journal of Korean Ancient History* 35:1–31 (in Korean).

Smith, B. D.
1998 *The Emergence of Agriculture.* New York: W. H. Freeman and Company.
2001 The transition to food production, in *Archaeology at the Millennium: A Sourcebook:* 199–229, ed. G. Feinman and T. Price. New York: Kluwer Academic/Plenum Publishers.

Sohn, P. K.
1980 *Chommal Cave Excavation Report.* Seoul: Yonsei University Museum (in Korean).
1982 *Sangnodaedo Excavation Report.* Seoul: Yonsei University Museum (in Korean).

Spennemann, D.H.R.
1987 Availability of shellfish resources on prehistoric Tongatapu, Tonga: Effects of human predation and changing environment. *Archaeology in Oceania* 22:81–96.

Stevens, D. W., and J. Krebs
1986 *Foraging Theory.* Princeton: Princeton University Press.

Sun, X. J., X. Li, Y. L. Luo, and X. D. Chen
2000 The vegetation and climate at the last glaciation on the emerged continental shelf of the South China Sea. *Palaeogeography, Palaeoclimatology, Palaeoecology* 160:301–316.

Winterhalder, B., and C. Goland
1993 On population, foraging efficiency, and plant domestication. *Current Anthropology* 34:710–715.
1997 An evolutionary ecology perspective on diet choice, risk, and plant domestication, in *People, Plants, and Landscapes:* 123–160, ed. K. J. Gremillion. Tuscaloosa: University of Alabama Press.

WINTERHALDER, B., AND E. A. SMITH
2000 Analyzing adaptive strategies: Human behavioral ecology at twenty-five. *Evolutionary Anthropology* 9:51–72.

YASUDA, Y.
1978 Prehistoric environment in Japan: Palynological approach. *Science Reports of Tohoku University* 28:117–281.
1984 Oscillations of climatic and oceanographic conditions since the last glacial age in Japan, in *The Evolution of the East Asian Environment:* 397–413, ed. R. O. Whyte. Hong Kong: Centre of Asian Studies, University of Hong Kong.

YESNER, D. R.
1980 Maritime hunter-gatherers: Ecology and prehistory. *Current Anthropology* 21:727–750.

YOKOYAMA, S.
1933 Report on the Tongsamdong shellmound, Yongdo, Pusan City. *Shizengaku Zasshi* 5:1–49 (in Japanese).

ZHANG, Y. E., AND C. J. NORTON
n.d. Counting in zooarchaeology and taphonomy. Unpublished manuscript.

ZHAO, Z. M.
1998 The middle Yangtze region in China is one place where rice was domesticated: Phytolith evidence from the Diaotonghuan Cave, Northern Jiangxi. *Antiquity* 72:885–897.

ZHENG, Z., AND Q. Y. LI
2000 Vegetation, climate, and sea level in the past 55,000 years: Hanjiang Delta, southeastern China. *Quaternary Research* 53:330–340.

ABSTRACT

As evidenced from the Korean archaeological record, there is an increased use of plant domesticates and a decrease in other food sources during the Holocene. These changes in overall human diet breadth culminate with the Late Neolithic–Bronze Age (c. 3500 B.P.) transition where dependence on hunted and gathered food packages decreases during the former period and full-scale agriculture becomes the norm during the latter cultural stage. This dietary shift appears to coincide with Holocene shoreline stabilization and overall large-scale population increase and movement through time. It is proposed here that two primary reasons exist for the change in overall diet breadth: (1) increasing shoreline stabilization during the Holocene and (2) an increase in hunter-gatherer population pressure due to a sedentary lifestyle. Both of these factors would have led to some degree of territorial circumscription, resulting in a progressive decline in overall hunter-gatherer foraging efficiency. In turn, this would have prompted the Holocene Korean Peninsular peoples to find other ways to offset their lowered overall foraging efficiency that had originally focused primarily on higher-ranked food resources (e.g., deer, wild boar). In this case, Korean peoples expanded their overall diet breadth to include a lower-ranked set of food packages (e.g., fish, shellfish) that by the advent of the Bronze Age eventually included plant domesticates regularly. KEYWORDS: East Asia, Korea, spread of agriculture, diet breadth contingency model, zooarchaeology.